MONITORING PLAN

PROJECT NO. C/S-17 CAMERON-CREOLE WATERSHED BORROW CANAL PLUG PROJECT

ORIGINAL DATE: May 28, 1996
REVISED DATE: July 23, 1998

Preface

Pursuant to a CWPPRA Task Force decision on April 14, 1998, the original monitoring plan was modified to conform with monitoring of projects of similar type. Specifically, water level and salinity will be monitored continuously through 2002. Upon collection and evaluation of the water level and salinity data set, the Technical Advisory Group (TAG) will determine if additional data collection is necessary. If additional monitoring is recommended, funds will be solicited. Additionally, post-construction soil sampling was omitted.

Project Description

The Cameron-Creole Watershed consists of 64,000 ac (25,900 ha) of brackish, intermediate, and fresh marsh located in Cameron Parish (figure 1). Since construction of the Calcasieu Ship Channel and dredging to a depth of 30 ft (9.1 m) in the 1940's, salt water intrusion from the Gulf of Mexico into the interior marshes via Calcasieu Lake has caused high rates of marsh loss. As a result, approximately 63,000 ac (25,200 ha) of brackish, intermediate, and fresh marsh on the East side of Calcasieu Lake were lost between 1950 and 1970, and replaced by brackish to saline marsh (Delany 1988). In 1989, a levee and 5 variable-crest water control structures were constructed along the east shore of Calcasieu Lake to reduce the movement of salt water into the Watershed. A borrow canal runs parallel to this levee. Management consists of manipulating the variable-crest water control structures located on Calcasieu Lake to retard the introduction of saltwater. Changes in the water movement patterns on the Cameron-Creole Watershed have resulted in rapid movement of saline water through the borrow canal, causing excessive pooling of saline water in the southern end (Delany 1991).

A primary goal in the management of the Cameron-Creole Watershed Management Project (CCWMP) is to restore the vegetative community and salinity regime to approximately their 1972 conditions. These conditions are outlined in "Changes in Vegetation in the Cameron Creole Marshes Over a Thirty-two Year Period" (USDA/SCS 1984). This document details the results of vegetative studies conducted in 1951, 1972, and 1983 by the Soil Conservation Service (SCS). In 1951, a fresh to intermediate marsh community dominated by *Cladium jamaicense* (Jamaica sawgrass) extended from the eastern project border at Highway 27, west to the east end of East Prong, north to the eastern turn of North Prong, and along the northern edge of Peconi Bayou to Calcasieu Lake. By 1972, the brackish marsh community composed mainly of *Spartina patens* (marshhay cordgrass)

Figure 1. Cameron Creole Watershed boundary and existing water control structures.

and *Distichlis spicata* (seashore saltgrass) had experienced an increase in *D. spicata*, the taxon more tolerant of higher salinities. This trend indicates an influence from saltwater intrusion. Brackish marsh composed mainly of *S. patens* has increased since 1972, expanding easterly to the upper East Prong of Grand Bayou and southerly at the upper South Prong of Grand Bayou. Between 1972 and 1988, the area of fresh and intermediate marsh was greatly reduced, becoming brackish marsh, or reverting to open water (USDA/SCS 1993). Based on the vegetative delineations of these studies, Natural Resources Conservation Service (NRCS, formerly SCS) and the United States Fish and Wildlife Service (USFWS) derived isohalines for management of salinity regimes in the watershed. The 12 ppt (part per thousand) isohaline is located at the junction of the East, West, North and South Prongs of Grand Bayou, near salinity station 6 (figure 2). The 5 ppt isohaline is located at the east end of East Prong, near station 7. Since installation of the levee and five water control structures in 1989, salinities in the project area have decreased (USFWS n. d.).

The C/S-17 project calls for installation of 2 sheetmetal plugs in the lakeshore borrow canal one just south of Grand Bayou and one south of Mangrove Bayou. The plug south of Mangrove Bayou, set at 1.5 ft (0.46 m) National Geodetic Vertical Datum (NGVD), will moderate the counterclockwise water circulation pattern observed in the northern project area. The C/S-17 project area affected by the plug south of Mangrove Bayou is depicted in figure 3. The vegetated marsh is composed of *S. patens*, *Scirpus olneyi* (Olney's three-cornered grass), *Paspalum vaginatum* (joint grass), *Typha* sp. (cattail), and *Phragmites australis* (common reed). Since 1990, salinities in the northern project area averaged 6 parts per thousand (ppt), with spikes to 16 ppt.

The eastern project area (figure 3) will be affected indirectly by the plug south of Mangrove Bayou by moderating water flow down Grand Bayou. The 5 ppt isohaline runs through the center of the area which is composed primarily of shallow open water ponds from 6" to 2' (0.15 to 0.61 m) deep and vegetated by *Ruppia maritima* (widgeon grass), *Myriophyllum spicatum* (Eurasian watermilfoil), and *Ceratophyllum demersum* (coontail). The broken emergent marsh, composed of *S. patens*, is subject to shoreline erosion caused by wind driven wave action across long fetches of open water. Anticipated benefits in this area include increased growth of submergent aquatic vegetation (SAV) which may aid in reducing erosion in the broken marsh.

The plug south of Grand Bayou, set at 1.0 ft (0.3 m) NGVD, will allow separate operation of the Grand Bayou and Lambert Bayou structures, increasing management capabilities for the entire watershed. It should also help prevent excessive pooling in the southern end of the watershed. The C/S-17 project area affected by the plug south of Grand Bayou is depicted in figure 3. The vegetated marsh is composed of *S. patens*, *D. spicata*, and *Spartina alterniflora* (oystergrass). Since 1990, salinities in the southern project area averaged 8 ppt with spikes to 20 ppt.

<u>Project Objectives</u>

1. Enhance and improve marsh condition in the C/S-17 project areas, approximately 2,500 ac (1,000 ha) of brackish marsh in the northern portion, 8,000 ac (3,200 ha) of brackish marsh in the southwest portion and 1,750 ac (700 ha) of brackish marsh in the eastern portion of the Cameron-Creole Watershed Management Project area.

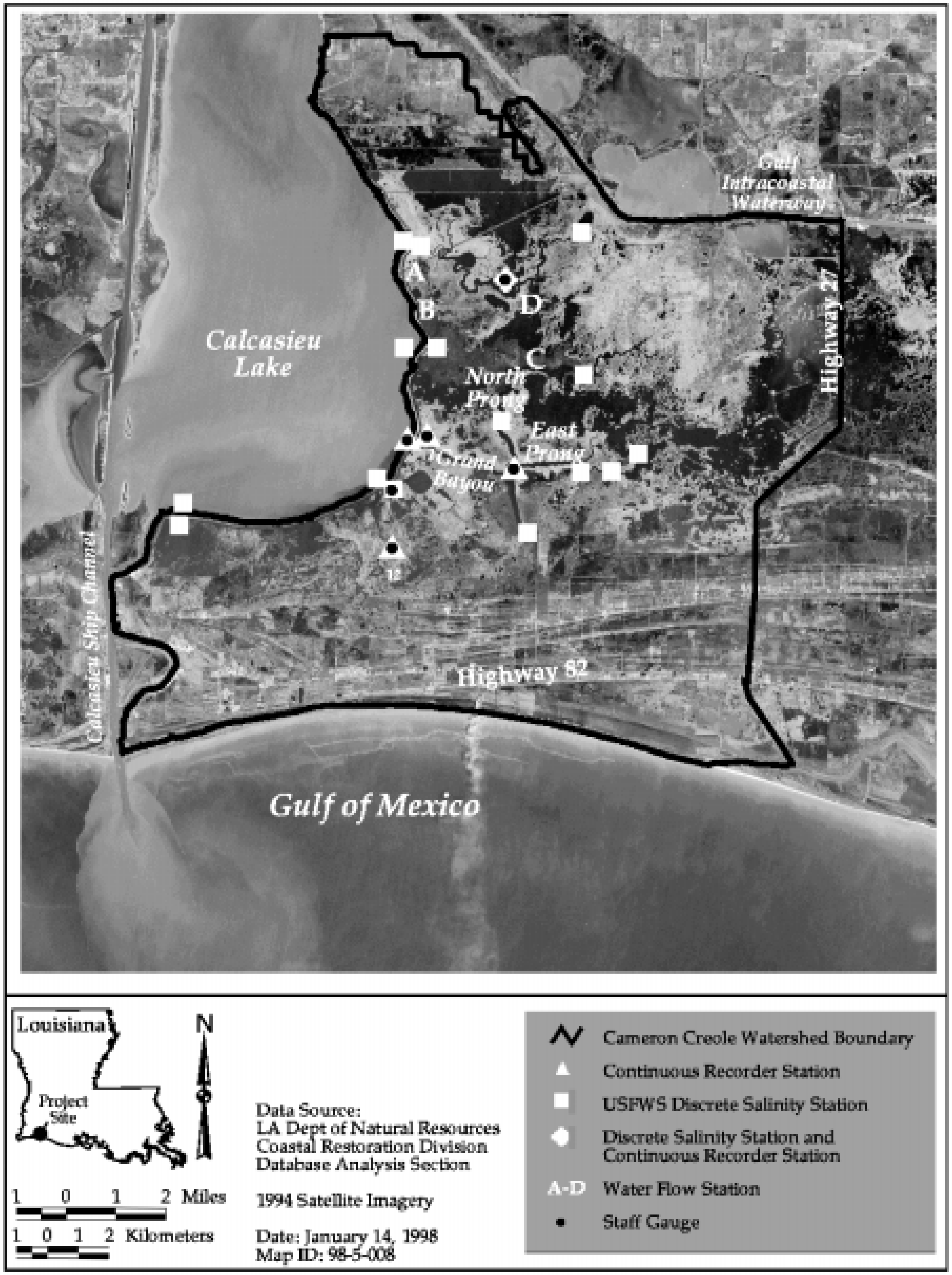

Figure 2 . Cameron Creole Watershed salinity and water flow stations.

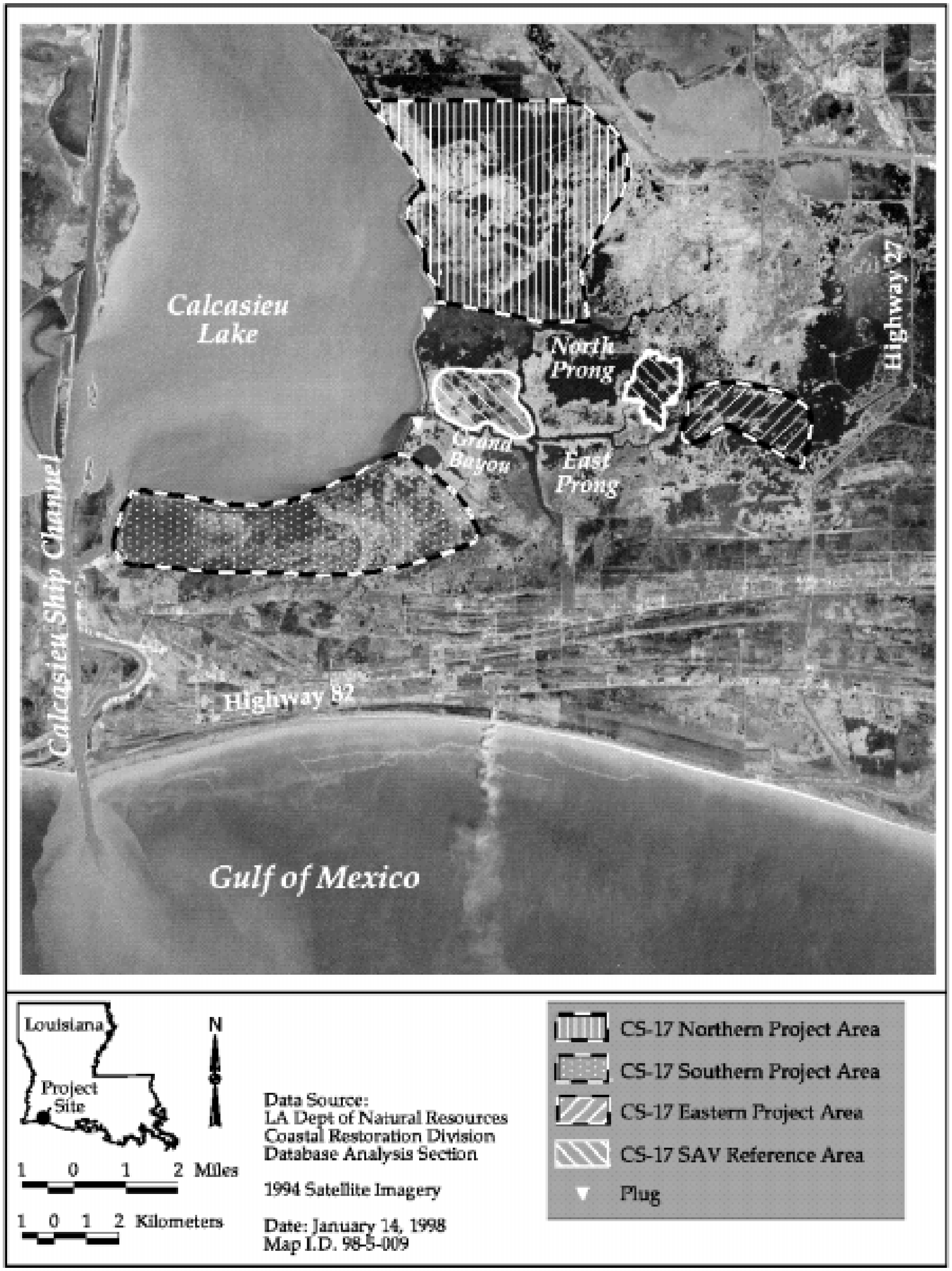

Figure 3. Cameron Creole Watershed borrow canal plugs, project areas, and reference areas.

2. Facilitate and accelerate present structural management capabilities by constructing 2 plugs in the lakeshore borrow canal to reduce flow in the borrow canal in the northern project area and to reduce duration of inundation in the southern project area (see Monitoring Limitations).

Specific Goals

The following measurable goals were established to evaluate project effectiveness:

1. Reduce duration of flooding in the southern C/S-17 project area.

2. Reduce water flow in the borrow canal in the northern C/S-17 project area (see Monitoring Limitations).

3. Increase coverage of emergent marsh plant species in the northern and southern C/S-17 project area.

4. Increase the frequency of occurrence of SAV in the eastern C/S-17 project area.

Reference Area

The importance of using appropriate reference areas cannot be overemphasized. Monitoring on both project and reference areas provides a means to achieve statistically valid comparisons, and is, therefore, the most effective means of evaluating project success. The evaluation of sites was based on the criteria that both project and reference area have a similar vegetative community, soil type, and hydrology. The marsh within the watershed, but outside of the project area is virtually impounded on all sides and is influenced by manipulation of the water control structures located along Calcasieu Lake, as is the project area. The marsh northeast of the Grand Bayou structure and north of West Prong is a suitable reference area (figure 3) for vegetation, water level, and soils. Soil type, vegetative community, and hydrology are similar. This area will not be under the influence of the proposed plugs, but does share the hydrology similar to the C/S-17 project area since it is subject to the influence of gate manipulations.

The ponds east of the North Prong of Grand Bayou (figure 3) are a suitable reference area for SAV. Pond size, depth, and existing vegetation are similar. The area is not expected to be influenced by the proposed plugs, but does share the hydrology similar to the C/S-17 project area since it is subject to the influence of gate manipulations.

Outside the boundaries of the Cameron Creole Watershed, no suitable reference area can be located. West of the Calcasieu Ship Channel, the majority of land is either presently managed by Sabine National Wildlife Refuge. Privately owned land in the vicinity that is not managed, has different soil types. An area on the northeast section of Calcasieu Lake was considered, but rejected since there is a proposed restoration project which is anticipated to be implemented within the year.

The proposed reference area northeast of the Grand Bayou structure and west of North Prong will be used in the evaluation of water levels, vegetation and soils. A proportional number of vegetation, and soil sample monitoring stations will be used within the reference area. The proposed reference area east of the North Prong of Grand Bayou will be used in the evaluation of SAV using methods identical to those used in the project area. Aerial photography for the habitat mapping monitoring element will be flown for the project area and both reference areas.

The reference areas chosen have some limitations. Because both reference areas are located within the Cameron Creole Watershed, it will be difficult to differentiate effects of the C/S-17 plug project from responses to gate manipulations carried out by USFWS personnel. Extensive preconstruction salinity and water level data analyzed in concert with structure operation records and climatological data may allow these effects to be separated. In addition, the C/S-17 plug project may have some effect on the proposed reference areas, however, it is anticipated that these effects will be minimal.

Monitoring Limitations

CRD endorses this monitoring plan as recommended by the Technical Advisory Group. However, due to monetary constraints, water level and salinity monitoring could not be monitored for the entire 20 year project life. This may prohibit our ability to adequately address duration and frequency of flooding in the southern project area.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Habitat Mapping — To document land and water areas and marsh loss rates, color infrared aerial photography (1:24,000 scale, with ground controls) will be obtained. The photography will be georectified, photointerpreted, mapped, and analyzed with GIS by the National Wetland Research Center (NWRC) using procedures as outlined in Steyer et al. (1995). The photography will be obtained in 1993 (pre-construction) and in 2010 (post-construction)(see Notes).

2. Salinity — Salinity will be monitored bi-weekly at 18 existing USFWS monitoring stations (Figure 2), 8 located inside the project area (Stations NNI, LBI, MBI, PBI, 5, 7, 10, 11, 12, and 13), and 8 located outside the project area (Stations NNO, LBO, MBO, PBO, 1, 2, 6, and 8). Discrete bi-weekly sampling is recorded with a YSI30 handheld salinometer by refuge personnel. YSI6000 continuous recorders at stations 1, 2, 11, and 12 collect salinities hourly and will be monitored in 1996 (pre-construction) and in 1997-2002 (post-construction).

   Upon collection of data (i.e. monthly readings from discrete stations and hourly readings from continuous data recorders) from 1996-2002, the TAG will assist the CRD monitoring manager with evaluation of the data and determination of whether additional salinity data collection is necessary. If additional monitoring is recommended, funds will be solicited.

Discrete and continuous data recorder stations may be added or removed within the project and reference areas as data become available and a power analysis can be performed. Salinity data will be used to characterize the spatial variation in salinity throughout the project area, and to determine if project area salinity is being maintained within the target range.

3. Water Flow

To monitor hydrologic conditions within the northern C/S-17 project area, water flow will be measured at 4 sites in the Peconi Bayou system (figure 2). Cross channel transects will be conducted using hand-held flow meters to characterize the vertical and horizontal flow structure (Boon 1978; Kjerfve et al. 1981) to calculate the instantaneous volume flux through the channel. The cross channel transects will be profiled every 2 hours from 7:30 am to 4:30 pm for a 72 hour period. Monitoring will be performed once pre-construction (1996) and once post-construction under similar conditions (i.e. drawdown).

4. Water Level

To monitor hydrologic conditions within the southern C/S-17 project area and document water levels, 3 staff gages are located at areas of water avenues connecting the project area to outside influences (11, 12, and LBI) and monitored bi-weekly by USFWS personnel (figure 2). Staff gages at LBI and 12 have been installed by DNR. Four staff gages are located outside of the project area (1, 2, 6, and south of station 8). Continuous recorders will collect water levels hourly at station 12 inside the project area and outside the project area at station 2. Elevations of continuous recorder gages have been surveyed relative to the marsh surface. NGVD will be the datum used. A temporary station within the reference area will be used to verify marsh level at station 2. Water level data will be used to document frequency and duration of marsh inundation. Hourly water levels will be monitored during 1996 (pre-construction) and in 1997-2002 (post-construction).

Upon collection of data (i.e. monthly readings from discrete stations and hourly readings from continuous data recorders) from 1996-2002, the TAG will assist the CRD monitoring manager with evaluation of the data and determination of whether additional water level data collection is necessary. If additional monitoring is recommended, funds will be solicited.

Discrete and continuous data recorder stations may be added or removed within the project and reference areas as data become available and a power analysis can be performed. Water level data will be used to characterize the spatial variation in water level throughout the project area, and to determine if project area water level is being maintained within the target range.

5. Vegetation — To monitor the relative species composition and general conditions of existing emergent vegetation within the project area, sixty sampling points (25 in the northern portion, 25 in the southern portion, and 10 in the reference area) will be chosen to document % cover, species composition, and height of dominant plants in plots a minimum of 1.0 m^2 using the Braun-Blanquet method outlined in Steyer et al. (1995). The plots will be marked with 2 corner poles to allow revisiting over time. Descriptive observations of SAV will be noted during monitoring of emergent vegetation. An identical sampling regime will be followed in the reference area. Vegetation will be monitored pre-construction in 1996 and at post-construction 1997, 2000, 2002, 2005, 2010, and 2015.

6. SAV — To determine the frequency of occurrence of SAV between the eastern project area and a reference area, within each study area, two ponds will be sampled for presence or absence of SAV at 25 random points using the rake method (Chabreck and Hoffpauir 1962). Species composition and frequency of occurrence will be determined in the late spring for each pond from the number of points at which SAV occurred and the total number of points sampled. SAV will be monitored once pre-construction in 1996, and in 1997, 2000, 2002, 2005, 2010, and 2015.

7. Sediments and Soils — To characterize soil condition, samples based on soil type will be taken in plots used for vegetative monitoring and analyzed for bulk density, percent of organic matter, and soil salinity. Soil condition will be monitored once in pre-construction during 1996.

<u>Anticipated Statistical Analyses and Hypotheses</u>

The following hypotheses correspond with the monitoring elements and will be used to evaluate the accomplishment of the project goals.

1. Descriptive and summary statistics will be used on both historical data and data collected during post project implementation to assess changes in marsh loss rates.

3. The primary method of analyses will be to determine differences in mean volume of flow between pre- and post-construction as evaluated by an analysis of variance (ANOVA) that will consider both spatial (stations) and temporal (day) variation and interaction. The direction of flow will be documented for every sampling measurement and will be included in the data analysis.

Goal: Reduce flows through the borrow canal.

Hypothesis:

H_0: Volume of flow post-construction will not be significantly lower than volume of flow pre-construction.

H_a: Volume of flow post-construction will be significantly lower than volume of flow pre-construction.

4. The primary method of analyses will be to determine differences in duration of marsh inundation as evaluated by ANOVA that will consider both spatial and temporal variation and interaction. The basic model of ANOVA will be BACI type model (Before-After-Control-Impact). This model will determine if there is detectable impact (for example, decrease in duration of marsh inundation) in the project area after construction. Multiple comparisons will be used to compare individual means across different treatment levels. All original data will be analyzed and transformed (if necessary) to meet the assumption of ANOVA (e.g. normality). When the H_0 is not rejected, the possibility of negative effects will be examined.

   Available ecological data, including both descriptive and quantitative data, will be evaluated in concert with the statistical analyses to aid in determination of the overall project success. This includes ancillary data collected in this monitoring project but not used directly in statistical analyses, as well as data available from other sources (USACE, USFWS, DNR, LSU, etc.).

   Goal: Decrease duration of inundation.

   Hypothesis$_1$:

   H_0: Duration of inundation post-construction will not be significantly lower than duration of inundation before construction.

   H_a: Duration of inundation post-construction will be significantly lower than duration of inundation before construction.

   Hypothesis$_2$:

   H_0: Duration of inundation within the project area will not be significantly less than duration of inundation within the reference area after construction.

   H_a: Duration of inundation within the project area will be significantly less than duration of inundation within the reference area after construction.

5. Vegetative cover will be examined utilizing ANOVA'S to monitor vegetation. If monitoring

results fail to reject the null hypothesis, negative effects will be investigated. Summary statistics will be performed on vegetative composition.

Goal: Increase vegetative cover.

Hypothesis$_1$:

H_0: Post-construction vegetative cover will not be significantly higher than vegetative cover before construction.

H_a: Post-construction vegetative cover will be significantly higher than vegetative cover before construction.

Hypothesis$_2$:

H_0: Vegetative cover within the project area will not be significantly higher than vegetative cover within the reference area after construction.

H_a: Vegetative cover within the project area will be significantly higher than vegetative cover within the reference area after construction.

6. Within a given sampling period, the Wilcoxan-Mann-Whitney Test will be used to test the hypothesis that there is no difference between the median frequency of SAV in the project area and the median frequency of SAV in the reference area (Siegel and Castellan 1988:128-137).

Goal: Increase frequency of occurrence of SAV.

Hypothesis:

H_0: Frequency of SAV in the project area at any time point i is not significantly greater than the frequency of SAV in the reference area at any time point i.

H_a: Frequency of SAV in the project area at any time point i is significantly greater than the frequency of SAV in the reference area at any time point i.

Over all sample dates, Repeated Measures Analyses will be used to compare the frequency of SAV between the project area and the reference area (Steele and Torrie 1980:377-437). These data will likely require transformation because percentage data with ranges between 0 and 20 or 80 and 100 often follow the Poisson distribution (Steele and Torrie 1980:3234-238). The square root plus 0.5 and the arcsin transformations are the most likely to correct heterogeneity of error associated with percentage data.

Hypothesis:

H_0: Frequency of SAV in the project area over time is not significantly greater than the frequency of SAV in the reference area over time.

H_a: Frequency of SAV in the project area over time is significantly greater than the frequency of SAV in the reference area over time.

Notes

1.	Implementation:	Start Construction:	November 1, 1996
		End Construction:	February 1, 1997
2.	USFWS Point of Contact:	Paul Yakupzack	(318) 598-2216
		Glenn Harris	(318) 598-2216
3.	DNR Project Manager:	Clay Menard	(318) 893-2769
	DNR Monitoring Manager:	Dona Weifenbach	(318) 893-2085
	DNR DAS Assistant:	Mary Horton	(504) 342-4122

4. The twenty year monitoring plan development and implementation budget for this project is $374,511. Progress reports will be available in February 1998 and February 2003, and comprehensive reports will be available in February 2001, February 2006, February 2011, and February 2017. These reports will describe the status and effectiveness of the project.
5. Data have been collected within the project area since 1987. Salinity and water level data are collected bi-weekly by the refuge personnel or by Miami Corporation. Stations 1, 2, 11, and 12 are currently equipped with YSI continuous data recorders. Station 6 is equipped with an H20 continuous data recorder.

6. DNR/CRD will assist USFWS refuge personnel with monitoring responsibilities.

7. Limiting aerial photography to once pre- and once post-construction may not be adequate for determining changes in habitat due to project implementation.

8. Due to monetary constraints, sampling frequency of monitoring may be revised to fit the budget. Any changes will be approved by the Technical Advisory Group prior to implementation.

9. References:

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